PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Fibrous Disposable Fluid Filter Medium

We, JOHNSON & JOHNSON, a Corporation organised under the Laws of the State of New Jersey, of New Brunswick, New Jersey, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention comprises filter media and in particular a fibrous disposable fluid filter medium suitable, for example, for use in vacuum cleaner bags or the filtration of viscose solutions.

Requirements for a completely satisfactory filter medium include retentiveness of particles of solid foreign material to be removed from the fluid material being filtered, and low pressure drop. These requirements generally work against each other since reduction in pressure drop is usually accompanied by loss in retentiveness and vice versa. However, it is desirable to obtain a filter medium having an acceptable balance of these qualities in having retentiveness as high as possible and pressure drop as low as possible. Other desirable but relatively less essential filter medium properties include soft fabric-like quality making them adaptable to being processed in bagging machines, low density and high tensile strength.

Prior attempts to formulate desirable vacuum cleaner filter media have been unsuccessful in that they have not resulted in a product having high retention of finely divided solid material consistent with satisfactory low pressure drop and have not produced a desired filter medium having a soft, fabric-like quality so as to be successfully processed in bagging machines.

An object of the invention is to produce a filter medium that possesses unusually high retentiveness without undue sacrifice with respect to pressure drop. A further object is to produce a filter medium which is light in weight (i.e., low density), possesses unusually soft, fabric-like feel and may be easily processed in bagging machines if desired. The medium may be used in a wide variety of applications in air filtration and may even be successfully used in filtration of liquids.

According to the invention a filter medium comprises a laminate of a layer of pulped fibres of a short length normally used in paper manufacture and a layer of textile fibres deposited thereon, the weight of the pulped fibre layer being in the approximate range of 200 to 1000 grains per square yard and having a porosity corresponding to about 0.5 to 2.0 inches of water pressure drop, for each 100 grains per square yard weight measured at 116 feet per minute linear air flow, the weight of the textile fibre layer being in the approximate range of 400 to 1600 grains per square yard and having a porosity corresponding to about 0.01 to 0.06 inches of water pressure drop, for each 100 grains per square yard weight measured at 116 feet per minute linear air flow, the laminate being through-bonded with no more than about 15% of a bonding agent based on the weight of the filter medium.

By "linear air flow" is meant the speed of air streaming through the material.

Preferably the pulped fibre layer is creped paper and has a weight in the approximate range of 400 to 800 grains per square yard and a porosity of about 0.7 to 1.5 inches of water pressure drop for each 100 grains per square yard weight measured at 116 feet per minute linear air flow. The textile fibre layer is of cotton fibres, and has a weight in the approximate range of 600 to 1000 grains per square yard and a porosity of about 0.01 to 0.06 inches of water pressure drop for each 100 grains per square yard weight measured at 116 feet per minute linear air flow. The textile fibre layer may include a

stratum, having a weight of about 100 to 500 grains per square yard of fine fibres adjacent to the pulped fibre layer and having a porosity of about 0.02 to 0.08 inches of water pressure drop for each 100 grains per square yard weight, measured at 116 feet per minute linear air flow.

The pulped fibre layer may be any of a variety of types of fibres deposited into a sheet by the usual paper process. The fineness of the fibres, as measured in a standard "Micronaire" instrument manufactured by the Sheffield Corporation of Dayton, Ohio, United States of America, should be not greater than about 3.0 micrograms per inch. Many of the wood pulp types of paper are suitable for invention purposes. Creped cellulose tissue, for example, having a single thickness weight of about 200 grains per square yard, is particularly suitable. The total weight of the pulped fibre layer is in the approximate range of 200 to 1,000 grains per square yard, preferably 400 to 800 grains per square yard. If desired, the weight of the pulped fibre layer may be made up by compositing a suitable number of sheets of the 200 grain per square yard creped cellulose tissue, and this, in fact, is often done. The porosity of the pulped fibre layer (bonded as described below) should be sufficiently high to minimize pressure drop but not unduly high so as to impair retentiveness. It has been found that if the porosity of a bonded pulped fibre layer is in the approximate range of 0.5 to 2.0, preferably 0.7 to 1.5, inches of water pressure drop per 100 grains per square yard of pulped fibres at an air flow speed through the layer of 116 feet per minute, a filter medium having sought for retentiveness may be obtained.

Adjoining the layer of pulped fibres there is disposed a layer of textile fibres which possesses a degree of porosity substantially greater and a pressure drop substantially lower than the layer of pulp fibres. The purpose of the textile fibre layer is to retard the larger particles of solid and/or gelatinous foreign material and thereby reserve the filtering potential of the pulped fibre layer for the finer solid particles. The weight of the textile fibre layer is chosen from the standpoint of maximum retention and lightness of weight of the filter medium, in the approximate range 400 to 1600 grains per square yard, preferably 600 to 1000 grains per square yard. The bonded fibre layer porosity which affords the advantages peculiarly characteristic of the invention filter medium lie within the approximate range of 0.01 to 0.06 inches of water pressure drop for each 100 grains per square yard of layer weight measured at 116 feet per minute linear air flow. This range of porosity corresponds approximately with average fibre fineness in the range 15 to 3 micrograms per inch as measured on a "Micronaire" fibre fineness tester manufactured by the Sheffield Corporation hereinbefore referred to.

For the purpose of illustrating the invention more clearly, reference is made to the attached drawing in which

Fig. 1 is a sectional view of one form of filter medium constructed according to the present invention; and

Fig. 2 is a modified form of invention filter medium.

Referring to Fig. 1, 10 represents a textile fibre layer and 11 illustrates a layer of pulped fibres, e.g., in the form of a sheet or a number of sheets of creped cellulose tissue paper. At 12 there is shown an under layer of textile fibres. Layers 10 and 11 together, even without layer 12, constitute the structure of the invention and afford the advantages of the invention. Layer 12 does not affect filter properties. However, layer 12 improves softness of hand and texture of the sheet from the standpoint of its ability to be sewn. All of these layers are secured together and bound to each other by a suitable bonding agent (described more fully below), which bonding agent permeates through the entire thickness of the sheet.

In the Fig. 2 structure, the pulped fibre layer 11 and lower textile fibre layer 12 serve the same purpose and are substantially equivalent to the layers of the Fig. 1 structure indicated by corresponding reference numbers. The Fig. 2 filter differs from the Fig. 1 filter in having the textile fibre layer divided into two strata. The top stratum 15 is substantially the same as the textile fibre layer 10 of Fig. 1. That is, it is composed of relatively coarse textile fibres having a bonded porosity in the approximate range of 0.01 to 0.06 inches of water pressure drop for each 100 grains per square yard measured at 116 feet per minute linear air flow, or alternatively expressed, fibre fineness in the approximate range 15 to 3 micrograms per inch. Stratum 16, on the other hand, is composed of textile fibres substantially finer than those of stratum 15. The stratum 16 fibres are, with respect to fineness, intermediate between the fibres of layer 11 and stratum 15. Stratum 16 has a weight of about 100 to 500 grains per square yard and porosity of about 0.02 to 0.08 inches of water pressure drop per 100 grains per square yard measured at 116 feet per minute linear air flow. Strata 15 and 16 taken together have an over-all weight of about 400 to 1600 grains per square yard and an over-all porosity of about 0.01 to 0.06 inches of water pressure drop per 100 grains per square yard measured at 116 feet per minute linear air flow just as for layer 10 of Fig. 1, and a fibre fineness of 15 to 3 mcgms/inch.

Although only two strata in the textile

fibre layer have been illustrated, if allowable cost will permit, more strata may be employed, each being progressively more porous as the distance from pulped fibre layer 11 is increased.

Cotton is a suitable fibre for use in layers 10 and 15-16; however, other textile fibres, natural or synthetic, which meet the requirements set forth above may be utilized.

The textile fibres are deposited in the order indicated on the pulped fibre sheet. This may be accomplished by any suitable means such as by deposition of the textile fibres from an air stream or by carding equipment. Carding is preferred. The bottom layer of textile fibres 12 is preferably added to pulp sheet 11 before adding the layer 10 or 15-16. After assembling all of the layers of the filter medium, the bonding agent is added. This is suitably accomplished by immersing the sheet in an aqueous solution of bonding agent, passing the saturated sheet between a pair of squeeze rolls to press out any excess liquid and then exposing the web, moistened throughout its thickness to contact with heated air. High viscosity polyvinyl alcohol (soluble in hot water but insoluble in cold) is a preferred bonding agent, but others suitable include synthetic rubber latices, latices of highly polymerized vinyl acetate or chloride, or solutions of starch, dextrin or gum arabic.

The concentration of bonding agent in the impregnating solution and the amount of solution remaining in the sheet after squeezing out the excess are controlled so as to restrict the amount of bonding agent in the final sheet and thereby prevent undue decrease of porosity of the filter media by reason of the presence of the bonding agent. Generally speaking, the bonding agent should not be present in an amount greater than 15% based on the weight of the filter medium. The preferred maximum amount is about 10% by weight.

By way of illustrating the invention, the following examples are presented, in which parts and percentages are expressed on a weight basis unless otherwise indicated.

EXAMPLE 1

A filter sheet was prepared by assembling one on top of the other three layers of creped wood pulp tissue, each individual sheet having a weight of 200 grains per square yard and an average fibre fineness as measured on the standard "Micronaire" instrument of 2.3 micrograms per inch. This triple thickness layer was superimposed on a layer of carded cotton textile fibres having a weight of 200 grains per square yard. On top of this composite on the side opposite the cotton there was deposited 800 grains per square yard of textile fibres consisting of a mixture of 75% cotton and 25% rayon, the mixture having an average fibre fineness of about 5.8 micrograms per inch. The web was then immersed in a warm aqueous solution of 1.5% strength hot water soluble, cold water insoluble polyvinyl alcohol binder and passed between a pair of squeeze rolls so as to press out all but about 250% water based on the bone dry weight of the web. The web was thereby moistened throughout this thickness with a bonding agent and subjected to drying with heated air in conventional equipment. The finished material contained 3.8% bonding agent deposited throughout the thickness of the sheet. By applying bonding agent and drying individual textile fibre and pulped fibre layers of the composite filter medium, it was determined that the porosity of the 800 grain per square yard textile fibre layer, as determined by forcing a stream of air through it and measuring the pressure drop in inches of water, was 0.02 inches of water for each 100 grains per square yard of material weight, measured at 116 feet per minute linear air flow. By a pressure drop measurement on the bonded pulped fibre sheet it was determined that its individual porosity was 1.1 inches of water per 100 grains per square yard. To test the filter material (Laminate) for retentiveness of solid particles, carbon black of 44 microns and under (smaller than 325 mesh size) was dispersed in an air stream and the air stream blown at a speed of 51 feet per minute through the invention filter medium. The stream was thereafter passed directly through a white filter paper to collect any material which was not retained by the filter medium under test. The amount of carbon black passing through the tested filter medium was determined by measuring the reflection of light from the surface of the white filter paper by a photoelectric instrument. A total of about 7.3 grams of carbon per square foot of filter material was used in testing the filter. The invention filter medium was compared with another type filter composed of cellulose fibres having a fineness as measured on the "Micronaire" of 3.5 micrograms per inch, a porosity of 0.22 inches of water pressure drop per 100 grains per square yard as measured by the standard method and a weight of 740 grains per square yard, by passing through the latter material carbon black of the same type and suspended in air just as in the evaluation procedure for invention filter media described. The pressure drop at the beginning and end of each test was also measured. The tests were run in duplicate. Results are presented in the table overleaf.

TABLE 1

Test Number	Sample	Air Resistance, Inches of Water Original	Final	% Reflection from Filter Paper (Original=100%)
1	Laminate A	2.9	6.8	92
2	Laminate A	2.7	7.4	89
3	Control A	0.5	9.2	55
4	Control A	0.5	6.9	66

EXAMPLE 2

The following laminated filtering sheets were prepared.

Laminate B was composed of two plies of creped wood pulp tissue, each of the plies having a weight of 200 grains per square yard and being substantially the same as the creped sheet described in connection with Example 1. On one side of the creped layer there was disposed 400 grains per square yard of cotton textile fibre of the type similarly disposed in Example 1. On the opposite side of the creped pulped layer there was disposed 400 grains per square yard of cotton textile fibres having a fineness of about 3.7 micrograms per inch as determined on the " Micronaire " and a porosity (when bonded) corresponding with 0.05 inches of water pressure drop for each 100 grains per square yard of material measured at 116 feet per minute linear air flow. Superimposed on the latter layer there was a layer of 600 grains per square yard of a 75% cotton-25% rayon mixture described in Example 1. The whole laminate was bonded throughout its thickness with 3.8% polyvinyl alcohol bonding agent based on the weight of dry fibres.

Control medium B consisted of a base layer of wide mesh cotton gauze superimposed by 300 grains per square yard of cotton textile fibres of a type substantially the same as utilized in the 400 grain centre layer in laminate B, in turn covered by a 600 grain per square yard layer of 50-50 mixture of cotton and rayon textile fibres having average fineness of 7.0 micrograms per inch as measured on the " Micronaire " and a porosity (when bonded) of about 0.02 inches of water pressure drop for each 100 grains per square yard of material measured at 116 feet per minute linear air flow. Control filter medium B was bonded throughout its thickness with about 3.8% polyvinyl alcohol just as for the other filter medium. To test these filter media for retentiveness of solid particles and pressure drop, carbon black of the type used in Example 1 (particle size of 44 microns under) was dispersed in an air stream and blown at a speed of 51 feet per minute through the filter medium. White filter paper was used to catch any material not retained by the media being tested. A total of about 7.3 grams of carbon per square foot of filter material was impinged on to the filter in each test. The results of the test are presented in the following table.

TABLE 2

Sample	Air Resistance Inches of Water Original	Final	% Reflection from Filter Paper (Original=100%)
Laminate B	0.9	2.6	64.5
Control B	0.2	0.7	0.0

EXAMPLE 3

Example 1 was repeated using finely pulverised cement instead of carbon black as a solid material to be retained by the filter. The same amount of cement was impinged on each filter tested. In other respects, the test conditions were the same as in Examples 1 and 2. The filter materials evaluated and the results of the test are presented in the table below.

TABLE 3

Sample	Air Resistance Inches of Water Original	Final	% Reflection from Filter Paper (Original=100%)
Laminate A	3.3	16.2	98.0
Laminate B	1.0	10.5	89.7
Control A	0.7	20.9	94.6
Control B	0.3	0.5	16.8

In all of the tests, a continuous layer of carbon or of cement on the filter paper would have produced a reflectometer reading of zero.

What we claim is:—

1. A filter medium comprising a laminate of a layer of pulped fibres of a short length normally used in paper manufacture and a

layer of textile fibres deposited thereon, the weight of the pulped fibre layer being in the approximate range of 200 to 1000 grains per square yard and having a porosity corresponding to about 0.5 to 2.0 inches of water pressure drop for each 100 grains per square yard weight, measured at 116 feet per minute linear air flow, the weight of the textile fibre layer being in the approximate range of 400 to 1600 grains per square yard and having a porosity corresponding to about 0.01 to 0.06 inches of water pressure drop for each 100 grains per square yard weight measured at 116 feet per minute linear air flow, the laminate being through-bonded with no more than about 15% of a bonding agent based on the weight of the filter medium.

2. A filter medium as claimed in Claim 1 in which the weight of the pulped fibre layer is in the approximate range of 400 to 800 grains per square yard and the weight of the textile fibre layer is in the approximate range of 600 to 1000 grains per square yard.

3. A filter medium as claimed in Claim 2 in which the pulped fibre layer has a porosity corresponding to about 0.7 to 1.5 inches of water pressure drop for each 100 grains per square yard weight measured at 116 feet per minute linear air flow, and the laminate is through-bonded with no more than about 10% of a bonding agent based on the weight of the filter medium.

4. A filter medium as claimed in any of the preceding claims in which the pulped fibre layer is creped paper and the textile layer is of cotton fibres deposited thereon.

5. A filter medium as claimed in any of the preceding claims in which the textile fibre layer includes a stratum, having a weight of about 100 to 500 grains per square yard, of fine fibres adjacent to said pulped fibre layer and having a porosity of about 0.02 to 0.08 inches of water pressure drop for each 100 grains per square yard weight measured at 116 feet per minute linear air flow.

6. A filter medium substantially as described in any of the foregoing examples except in so far as they refer to control media.

7. A filter medium substantially as described with reference to the accompanying drawings.

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745,030 COMPLETE SPECIFICATION
1 SHEET
This drawing is a reproduction of the Original on a reduced scale.

Fig. 1.

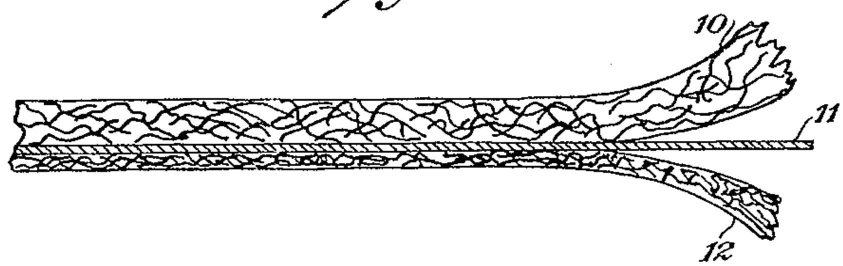

Fig. 2.